

## Analysis of SSEM Sensor Data Using BEAM

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A report describes analysis of space shuttle main engine (SSME) sensor data using Beacon-based Exception Analysis for Multimissions (BEAM) [NASA Tech Briefs articles, the two most relevant being "Beacon-Based Exception Analysis for Multimissions" (NPO-20827), Vol. 26, No.9 (September 2002), page 32 and "Integrated Formulation of Beacon-Based Exception Analysis for Multimissions" (NPO-21126), Vol. 27, No. 3 (March 2003), page 74] for automated detection of anomalies. A specific implementation of BEAM, using the Dynamical Invari-

ant Anomaly Detector (DIAD), is used to find anomalies commonly encountered during SSME ground test firings. The DIAD detects anomalies by computing coefficients of an autoregressive model and comparing them to expected values extracted from previous training data. The DIAD was trained using nominal SSME test-firing data. DIAD detected all the major anomalies including blade failures, frozen sense lines, and deactivated sensors. The DIAD was particularly sensitive to anomalies caused by faulty sensors and unexpected transients. The system of-

fers a way to reduce SSME analysis time and cost by automatically indicating specific time periods, signals, and features contributing to each anomaly. The software described here executes on a standard workstation and delivers analyses in seconds, a computing time comparable to or faster than the test duration itself, offering potential for real-time analysis.

*This work was done by Michail Zak, Han Park, and Mark James of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-30664*

## Hairlike Percutaneous Photochemical Sensors

**Mass-produced, inexpensive sensors would be small enough to be minimally invasive.**

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Instrumentation systems based on hairlike fiber-optic photochemical sensors have been proposed as minimally invasive means of detecting biochemicals associated with cancer and other diseases. The fiber-optic sensors could be mass-produced as inexpensive, disposable components. The sensory tip of a fiber-optic sensor would be injected through the patient's skin into subcutaneous tissue. A biosensing material on the sensory tip would bind or otherwise react with the biochemical(s) of interest [the analyte(s)] to produce a change in optical properties that would be measured by use of an external photonic analyzer. After use, a fiber-optic sensor could be simply removed by plucking it out with tweezers.

A fiber-optic sensor according to the proposal would be of the approximate size and shape of a human hair, and its sensory tip would resemble a follicle. Once inserted into a patient's subcutaneous tissue, the sensor would even more closely resemble a hair growing from a follicle (see Figure 1). The biosensing material on the sensory tip could consist of a chemical and/or cells cultured and modified for the purpose. The biosensing material would be con-

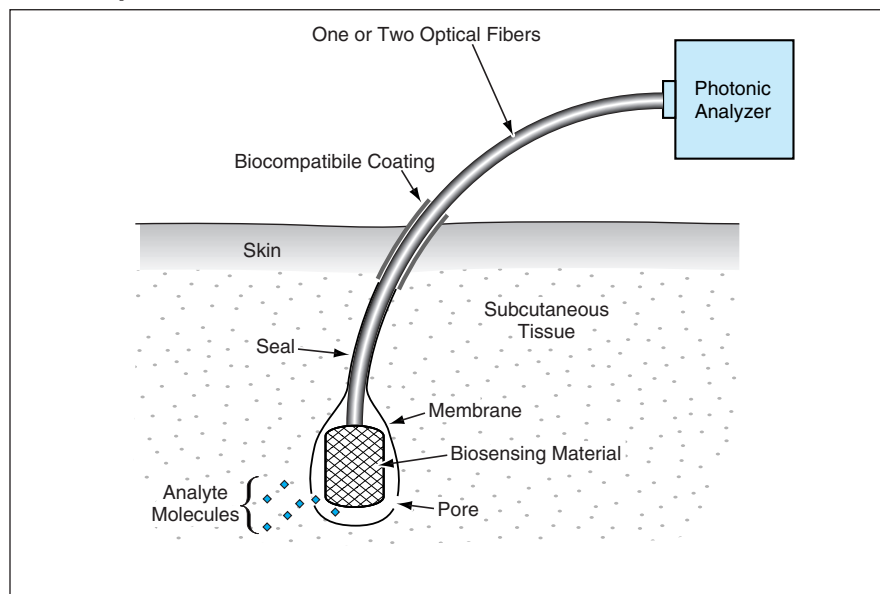


Figure 1. A **Fiber-Optic Sensor** would be implanted through the skin into subcutaneous tissue. The sensory tip would contain a biosensing material that, upon reaction with analyte molecules, would undergo a change in optical properties.

tained within a membrane that would cover the tip. If the membrane were not permeable by an analyte, then it would be necessary to create pores in the membrane that would be large enough to allow analyte molecules to diffuse to the biosensing material, but not so large as

to allow cells (if present as part of the biosensing material) to diffuse out. The end of the fiber-optic sensor opposite the sensory tip would be inserted in a fiber-optic socket in the photonic analyzer.

The basic concept of photonic detection of an analyte admits of the use of